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Atlas of Alberta's

Crude Bitumen Reserves

At 31 December

1984

DDN 5668851

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Atlas of Alberta's

Crude Bitumen Reserves

At 31 December

1984

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Published by:

Energy Resources Conservation Board
640 Fifth Avenue, SW
Calgary, Alberta
T2P 3G4

Telephone (403) 297-8311
Telex 03-821717

Price $10.00

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PREFACE

Since 1977, the initial volume of crude bitumen in place within Alberta's designated oil-sands deposits has been determined using a building-block approach. This approach is a refinement of an evaluation method developed by Energy Resources Conservation Board staff for a paper[1] presented at the 28th Annual Technical Meeting of the Petroleum Society of CIM. The results of the Board's evaluations appear in the Atlas of Alberta's Crude Bitumen Reserves. The Atlas shows the estimated initial in-place volumes for each oil-sands deposit.

This third edition of the Atlas includes updated building-block maps and tabulations for the Athabasca Wabiskaw-McMurray in situ and surface mineable deposits as well as a number of deposits in the Cold Lake and Peace River areas.

In 1981, in-place volumes within the Grosmont carbonate were determined based on isopachous mapping. In this update, reserves within the southern Cold Lake area (Lindbergh) as well as established reserves in Esso's commercial area are also based on isopachous mapping rather than the building-block method.

---

[1] Outtrim, C. P., and R. G. Evans, 1977. Alberta's Oil Sands Reserves and their Evaluation. 28th Annual Technical Meeting of the Petroleum Society of CIM.

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1 CRUDE BITUMEN RESERVES

Alberta's crude bitumen reserves are interpreted by the Board from geological information on the oil-sands deposits occurring in east-central and northern Alberta. Oil Sands are defined as "sands and other rock materials containing crude bitumen, the crude bitumen contained in those sands and other rock materials, and any other mineral substances, other than natural gas, in association with that crude bitumen".[1] An Oil Sands deposit may be designated by the Board by describing the surface area vertically above the Oil Sands deposit and by naming the geological formation, member, or zone in which the Oil Sands deposit occurs.[2]

Alberta's deposits of oil sands are designated through Oil Sands Deposit (OSD) Orders. The oil sands are of Cretaceous and Devonian age and include the Athabasca, Cold Lake, and Peace River areas. Devonian age occurrences are present within the porous carbonate rocks which subcrop beneath the Cretaceous sands in northern Alberta. To date, Devonian age deposits have been designated within the Grosmont, Nisku, Shunda, and Debolt carbonates. The Deposit outlines are shown on Map 1. Alberta's oil sands areas are designated through Oil Sands Area (OSA) Orders. Three such areas have been declared, the Athabasca Oil Sands Area (OSA 1), the Peace River Oil Sands Area (OSA 2), and the Cold Lake Oil Sands Area (OSA 3). The Area outlines are shown on Map 1.

As a result of the recent issuance of OSA orders, the Buffalo Head Hills Bluesky-Gething Deposit has been redesignated as a Peace River Deposit; and in addition the Upper and Lower Grand Rapids and the Wabiskaw-McMurray reserves in the general Lindbergh-Elk Point area, previously included in the heavy oil reserves, have been declared crude bitumen reserves and are included in the Cold Lake Area (Table 3-1). Zones affected by the re-classification of the Lindbergh area are the Colony (Upper Grand Rapids), Sparky, General Petroleum, and Lloydminster (Lower Grand Rapids), and the Cummings and McMurray (Wabiskaw-Murray).

---

[1] Section 1(1)(n) of the Oil Sands Conservation Act, c.0-5.5 SA 1983.
[2] Section 7(3) of the Oil Sands Conservation Act.

Figure 2 illustrates the division of the sands in a typical well in the Lindbergh area.

2 INITIAL VOLUMES OF CRUDE BITUMEN IN PLACE

Initial volume in place is defined as the gross volume of crude bitumen calculated or interpreted to exist in a deposit before any bitumen has been produced. The 1984 initial volumes of crude bitumen in place, for all deposits except the carbonates and the Lindbergh and Esso commercial areas, were determined by the building-block method described below.

Using all drill-hole data available to 31 December 1984, Board staff evaluated the net bitumen pay thickness, average porosity, and average bitumen saturation based on cut-offs of 3 mass per cent bitumen and a saturated zone thickness of 1.5 metres. Where more than one hole had been drilled in a quarter-township, the data were summarized and averaged within the quarter-township block to arrive at its volume in place. The net oil column thickness was multiplied by the area, with the northwest and northeast quarter-townships assigned an area of 2369.8 hectares each, and the southwest and southeast quarter-townships 2379.6 hectares (the difference representing the area devoted to road allowances).

The initial volumes in place determined from the drilled wells and the assigned areas were plotted on the map in the appropriate blocks. Quarter-township blocks containing no drilled wells were assigned inferred volumes based on the lowest volume from those of adjacent blocks. Where the available drilling data indicated no pay in a block, a no-pay or zero reserve was inferred in all adjacent blocks where no drilling had occurred. Inferred volumes were assigned only towards the known reserve accumulations. The total volumes in place were then determined by adding the initial and inferred volumes from each block.

The method of assuming volumes in place for some undrilled blocks is fairly conservative. However, compared to the use of contour maps, the building-block method of interpolation has two advantages:

consistency, because little judgement is involved in the interpolation and summation process, and ease of revision as new data become available. Initial in-place volumes of bitumen within the carbonate deposits, including the Athabasca Grosmont and Nisku, and the Peace River, Shunda, and Upper and Lower Debolt, have been determined based on isopachous mapping, rather than the building-block approach, due to the low density of well control throughout the deposit areas. A minimum bitumen saturation of 30 per cent of pore volume and a porosity cut-off of 5 per cent were used in these evaluations. A typical well log showing the A, B, C and D zones in the Athabasca Grosmont is illustrated in Figure 1.

Initial in-place volumes of bitumen in the Lindbergh Area were also determined based on isopachous mapping. A porosity cut-off of 20 per cent was used in these evaluations; no thickness cut-offs were applied.

3 OIL-SANDS DEPOSITS

3.1 ATHABASCA

The Board has designated six deposits in the Athabasca area. The Athabasca Wabiskaw-McMurray Deposit (OSD 1) contains massive, continuous non-marine clastic sands and shales of the McMurray Formation plus the overlying Wabiskaw Member of the Clearwater Formation. This is the largest of the deposits, extending from townships 67 to 103, and from range 2, west of the 4th meridian to range 5, west of the 5th meridian.

The Athabasca Upper (OSD 5), Middle (OSD 10), and Lower Grand Rapids (OSD 11) deposits previously designated as Wabasca Deposits, are contained in three fairly massive, continuous sands of non-marine origin extending from townships 70 to 87, and from range 13, west of the 4th meridian to range 4, west of the 5th meridian.

The Athabasca Grosmont Deposit (OSD 12) and the Athabasca Nisku Deposit (OSD 13) subcrop beneath the west-central portion of the Athabasca Wabiskaw-McMurray Deposit, and extend from approximately township 62, range 12, west of the 4th meridian to township 101, range 3, west of the 5th meridian. Bitumen saturation occurs at the updip edge of the Grosmont and Nisku formations down to a depth of approximately 30 metres subsea.

The surface mineable area of the Athabasca Wabiskaw-McMurray Deposit as at 31 December 1984 is shown on Map 18 and has been extended this year to include township 95, range 7; township 97, range 6; and township 98, range 7, all west of the 4th meridian.

The mineable areas were identified by economic stripping ratio criteria which are fully explained in Appendix III of ERCB Report 79-H[1]. An isopach map of total discard (overburden plus top reject) for the surface mineable area is shown on Map 19.

---

[1] Energy Resources Conservation Board, December 1979, Alsands Fort McMurray Project, ERCB Report 79-H. Calgary, Alberta.

3.2 COLD LAKE

The Board has designated four deposits in the Cold Lake area of east-central Alberta. The Cold Lake Upper Grand Rapids Deposit (OSD 3) extends from townships 53 to 66, ranges 1 to 12, west of the 4th meridian, and is made up of several non-marine sands of varying thicknesses complicated by channels filled with sand or shales. The Cold Lake Lower Grand Rapids Deposit (OSD 9) is a non-marine feldspathic sand extending from townships 53 to 69, ranges 1 to 11, west of the 4th meridian. The Cold Lake Clearwater Deposit (OSD 4) is a marine sandstone sequence, fairly continuous and massive, extending from townships 58 to 69, ranges 1 to 13, west of the 4th meridian. Oil sands within the Wabiskaw-McMurray Formation are stratigraphically adjacent to one another within all portions of the Athabasca and Cold Lake deposits. The Board therefore redesignated the Cold Lake McMurray Deposit (OSD 8) as the Cold Lake Wabiskaw-McMurray Deposit; it is made up of discontinuous and sporadically distributed non-marine sandstones overlying Devonian formations extending from townships 53 to 69, ranges 1 to 12, west of the 4th meridian.

3.3 PEACE RIVER

The Board has designated five deposits in the Peace River area of north-central Alberta. The Peace River Bluesky-Bullhead Deposit (OSD 2) extends from townships 78 to 92, ranges 8 to 25, west of the 5th meridian. The crude bitumen occurs in the Bluesky, Gething, and Cadomin formations of the Bullhead group. The Buffalo Head Hills Bluesky-Gething Deposit (OSD 7) has been redesignated as a Peace River Deposit. Crude bitumen occurs within thin discontinuous sections of sandstone and siltstone, shale and coal. The deposit extends from townships 93 to 99 and from ranges 7 to 17, west of the 5th meridian.

The contact between the Gething and Bluesky is difficult to determine, as the sequence is gradational from non-marine to marine. These formations are underlain by subcropping strata of Permian and Mississippian ages that also contain crude bitumen.

The Mississippian, encompassing the Upper Debolt Deposit (OSD 15), the Lower Debolt Deposit (OSD 16), and the Shunda Deposit (OSD 14), were evaluated for in-place reserves for a limited area of the total formational extent. The area of evaluation extends from townships 83 to 86, ranges 16 to 19, west of the 5th meridian.

TABLE 1 RESERVES OF CRUDE BITUMEN AND BASIC DATA, AS AT 31 DECEMBER 1984

Area, Deposit Overburden Depth, Zone	1 Initial Volume in Place	2 Areal Extent	3 Average Pay Thickness	4 Average Bitumen Content		5 Average Porosity	6 Average Water Saturation
m	10^6 m^3	10^3 ha	m	fraction by mass	fraction by vol.	fraction by vol.	pore volume fraction
ATHABASCA							
Wabiskaw-McMurray							
0- 20	7 190	97	33	0.101		0.30	0.30
20- 40	9 990	128	38	0.098		0.30	0.28
40- 80	7 220	100	36	0.095		0.30	0.31
80-120[a]	2 270	26	46	0.098		0.30	0.30
80-750+	117 800	4 329	19	0.069		0.28	0.38
Subtotal	144 470						
Upper Grand Rapids							
150-450+	4 140	334	9	0.062		0.30	0.45
Subtotal	4 140						
Middle Grand Rapids							
150-450+	1 410	182	5	0.077		0.30	0.32
Subtotal	1 410						
Lower Grand Rapids							
150-450+	1 220	173	6	0.051		0.30	0.55
Subtotal	1 220						
Grosmont							
D	19 890	1 063	16		0.67	0.20	0.33
C	15 390	1 189	10		0.75	0.16	0.25
B	5 380	976	5		0.69	0.15	0.31
A	9 840	939	10		0.60	0.14	0.40
Subtotal	50 500						
Nisku							
200-800+	10 330	499	8		0.55	0.21	0.37
Subtotal	10 330						
COLD LAKE							
Upper Grand Rapids							
300-600	7 400	816	6	0.065		0.30	0.42
Subtotal	7 400						
Lower Grand Rapids							
Cold Lake Area	11 647	741	12	0.069		0.31	0.40
Lindbergh Area							
Sparky	45	7	4	0.074		0.31	0.30
Lower Grand Rapids #2	15	3	3	0.099		0.31	0.31
Lower Grand Rapids #3	40	4	5	0.085		0.31	0.26
Lower Grand Rapids #4	180	22	4	0.092		0.33	0.24
Lloydminster	275	10	12	0.102		0.33	0.21
Subtotal	12 202						
Clearwater							
300-600	10 620	561	12	0.072		0.30	0.44
Subtotal	10 620						
Wabiskaw-McMurray							
Cold Lake Area	3 165	582	6	0.057		0.25	0.49
Lindbergh Area							
Cummings #1	283	32	5	0.089		0.30	0.27
Cummings #2	235	25	5	0.089		0.31	0.24
McMurray	272	27	5	0.093		0.31	0.19
Subtotal	3 955						
PEACE RIVER							
Bluesky-Gething							
300-700	500	187	4	0.061		0.24	0.48
Subtotal	500						
Bluesky-Bullhead							
300-750+	11 400	800	14	0.45		0.24	0.58
Subtotal	11 400						
Upper Debolt							
500-800	1 580	60	13		0.61	0.19	0.39
Subtotal	1 580						
Lower Debolt							
500-800	4 310	96	32		0.70	0.18	0.30
Subtotal	4 310						
Shunda							
500-800	1 540	72	14		0.54	0.20	0.46
Subtotal	1 540						
Total[b]	265 577						
	(1 670 429)[c]						

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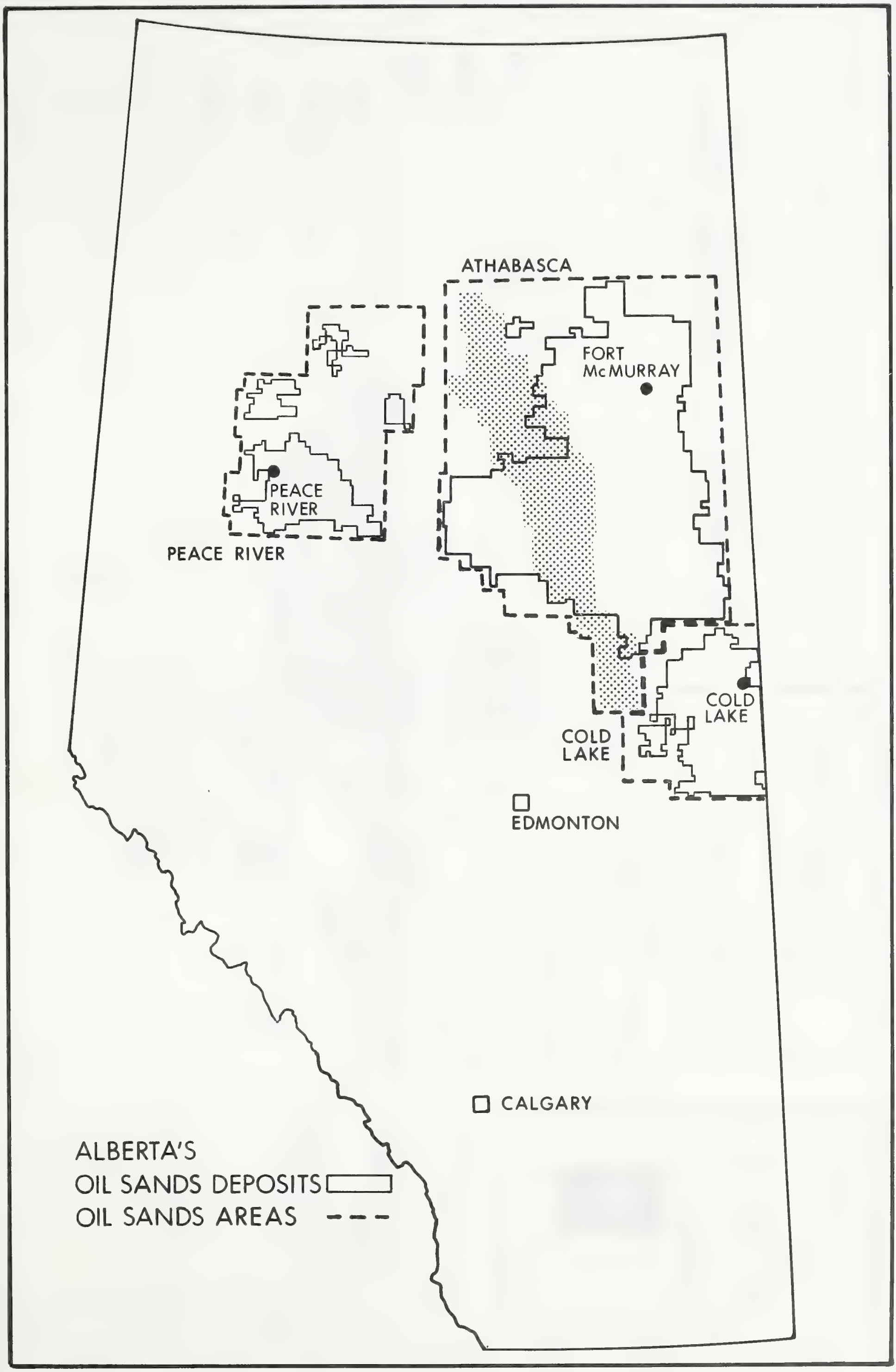
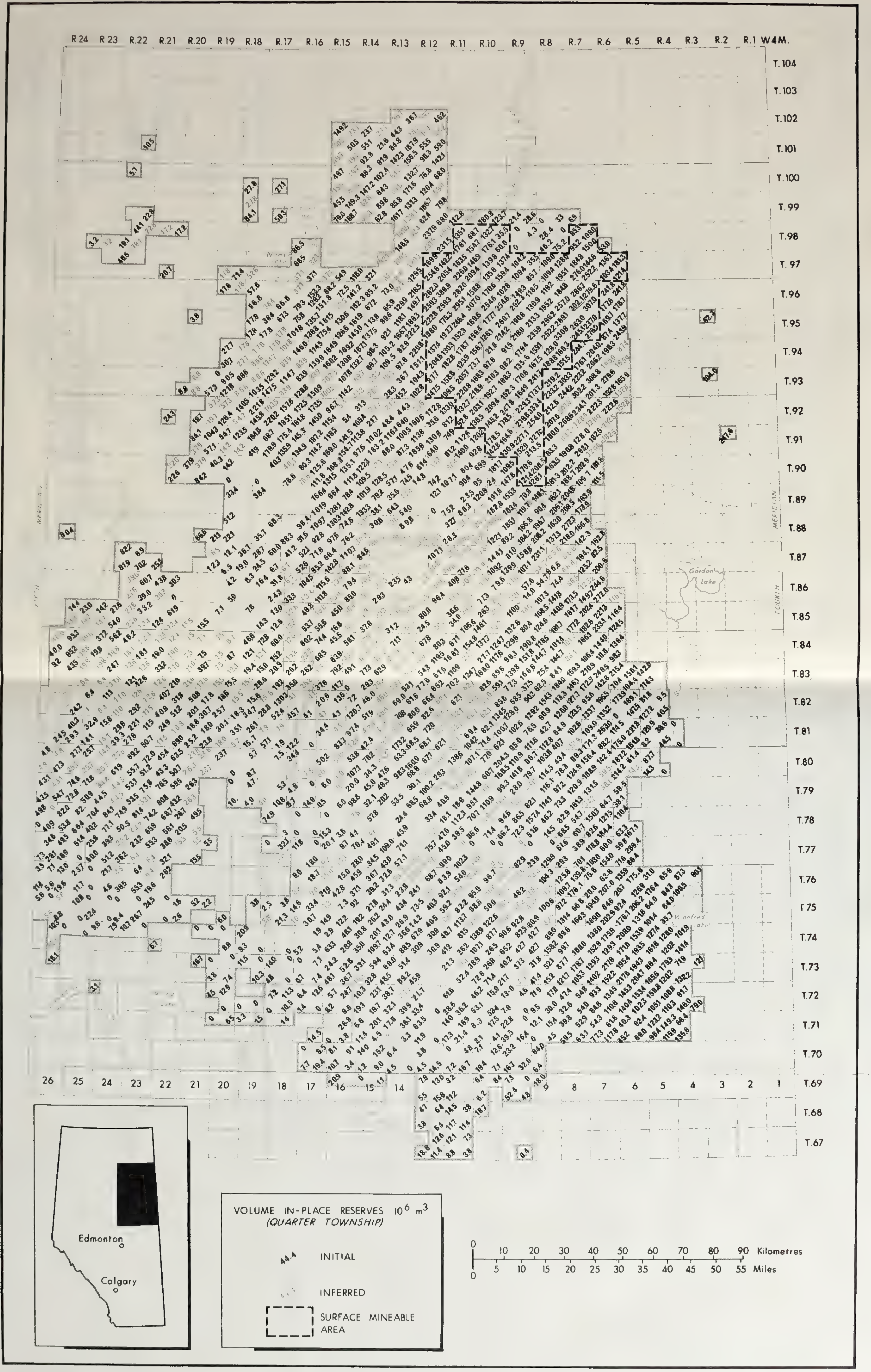
a Within the current mineable area.
b Discrepancies are due to rounding.
c Imperial equivalent in million of barrels.

Map 1

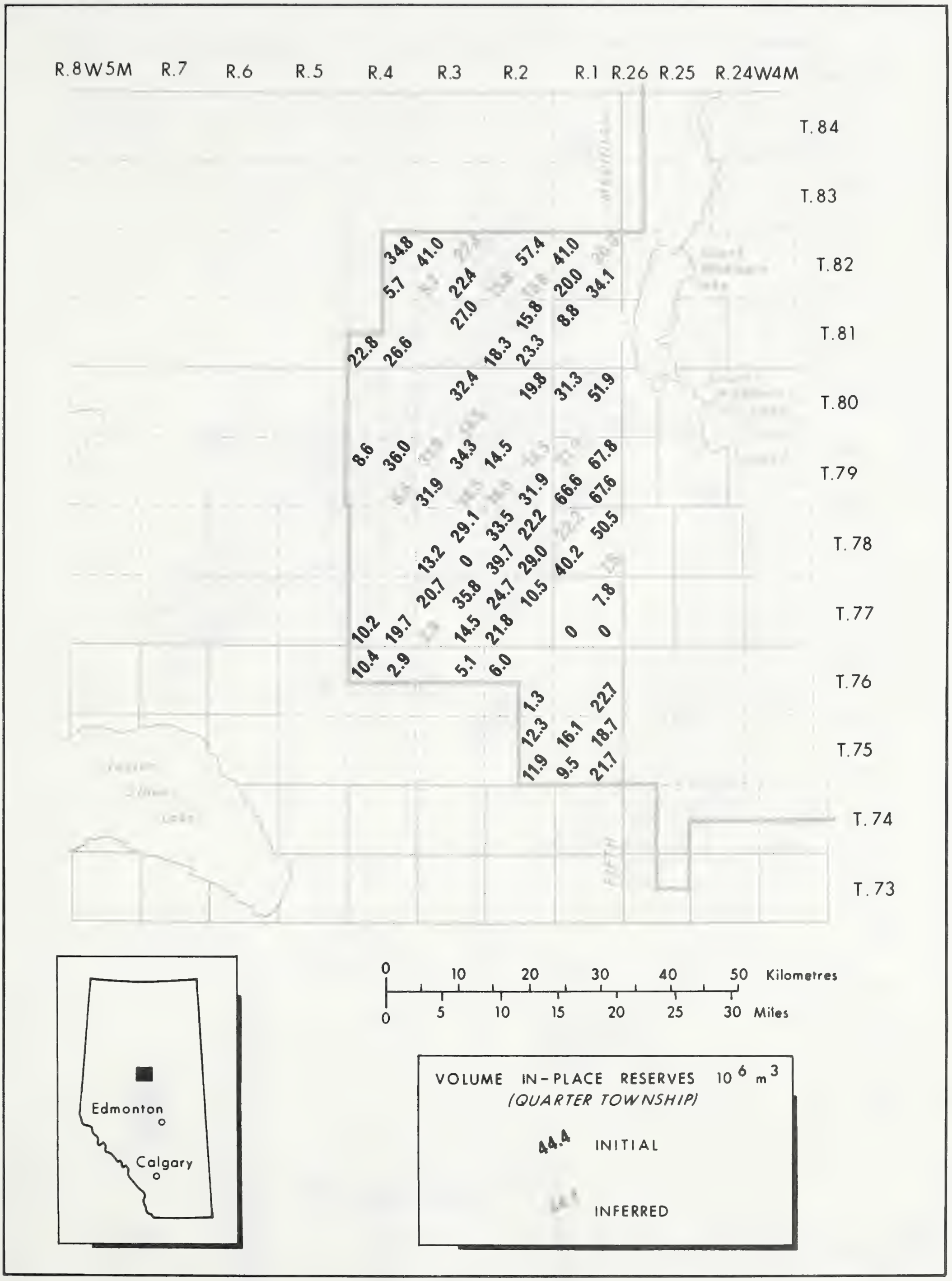

ATHABASCA
FORT McMURRAY
PEACE RIVER
PEACE RIVER
COLD LAKE
COLD LAKE
EDMONTON
CALGARY
ALBERTA'S
OIL SANDS DEPOSITS
OIL SANDS AREAS

Map 2



ATHABASCA WABISKAW - McMURRAY 1984

ERCB



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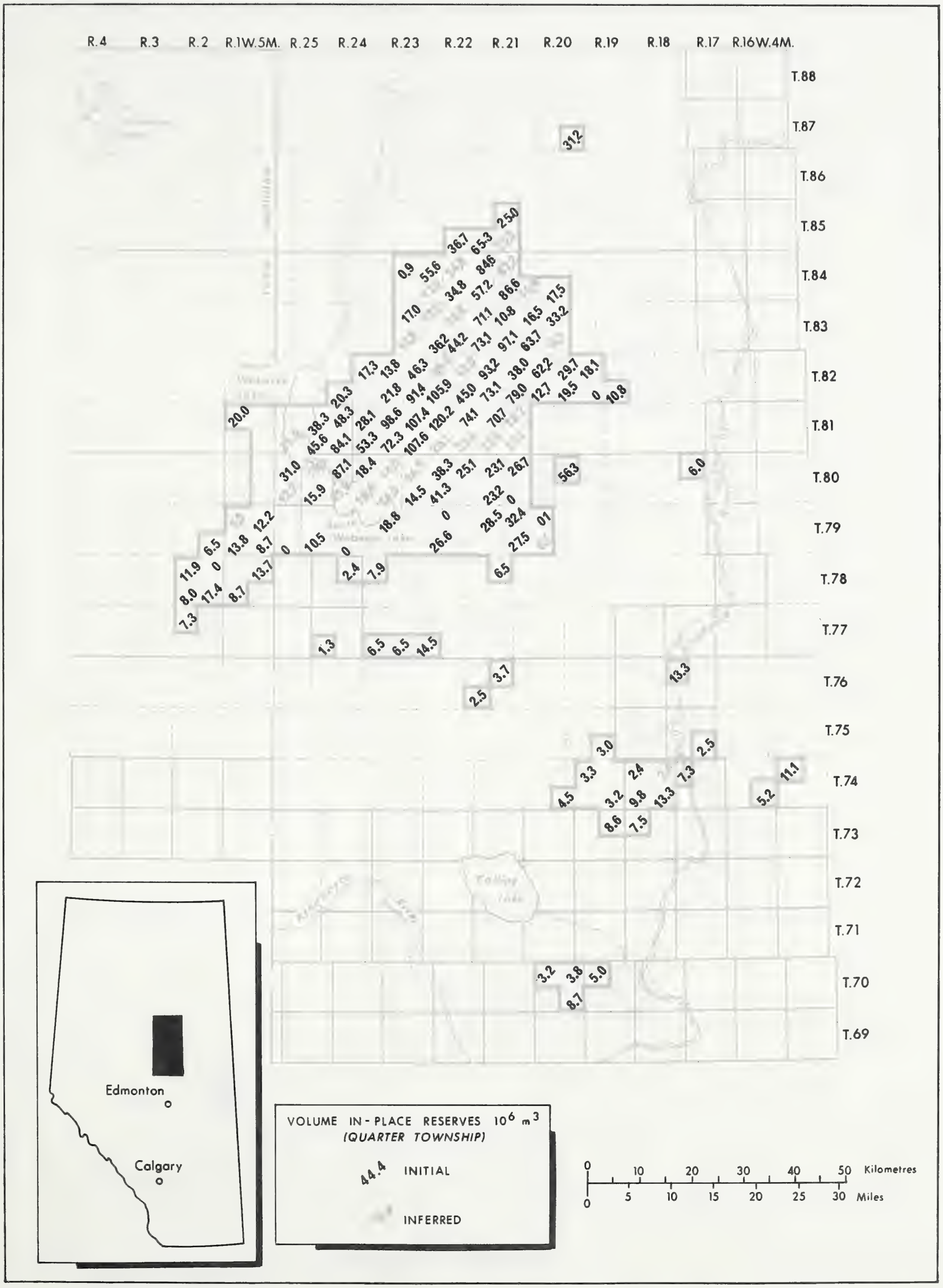
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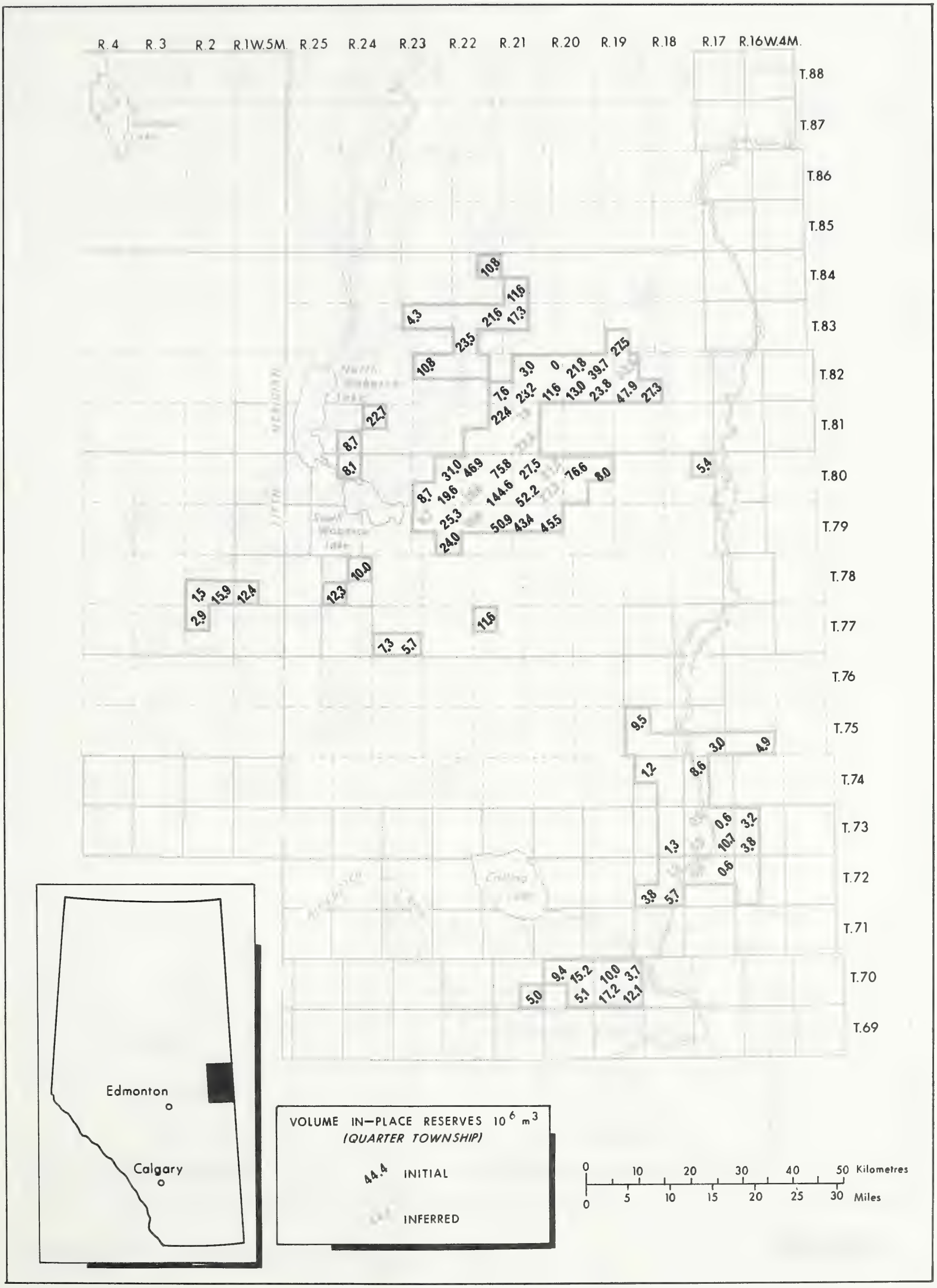
5.0
8.7
Wabasca Lake
South Wabasca Lake
Calling Lake
Edmonton
Calgary
VOLUME IN-PLACE RESERVES 10^6 m^3
(QUARTER TOWNSHIP)
44.4 INITIAL
INFERRED
0 10 20 30 40 50 Kilometres
0 5 10 15 20 25 30 Miles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North Wabasca Lake
South Wabasca Lake
MERIDIAN
FIFTH
Calling Lake
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11.6
4.3
21.6
17.3
23.5
27.5
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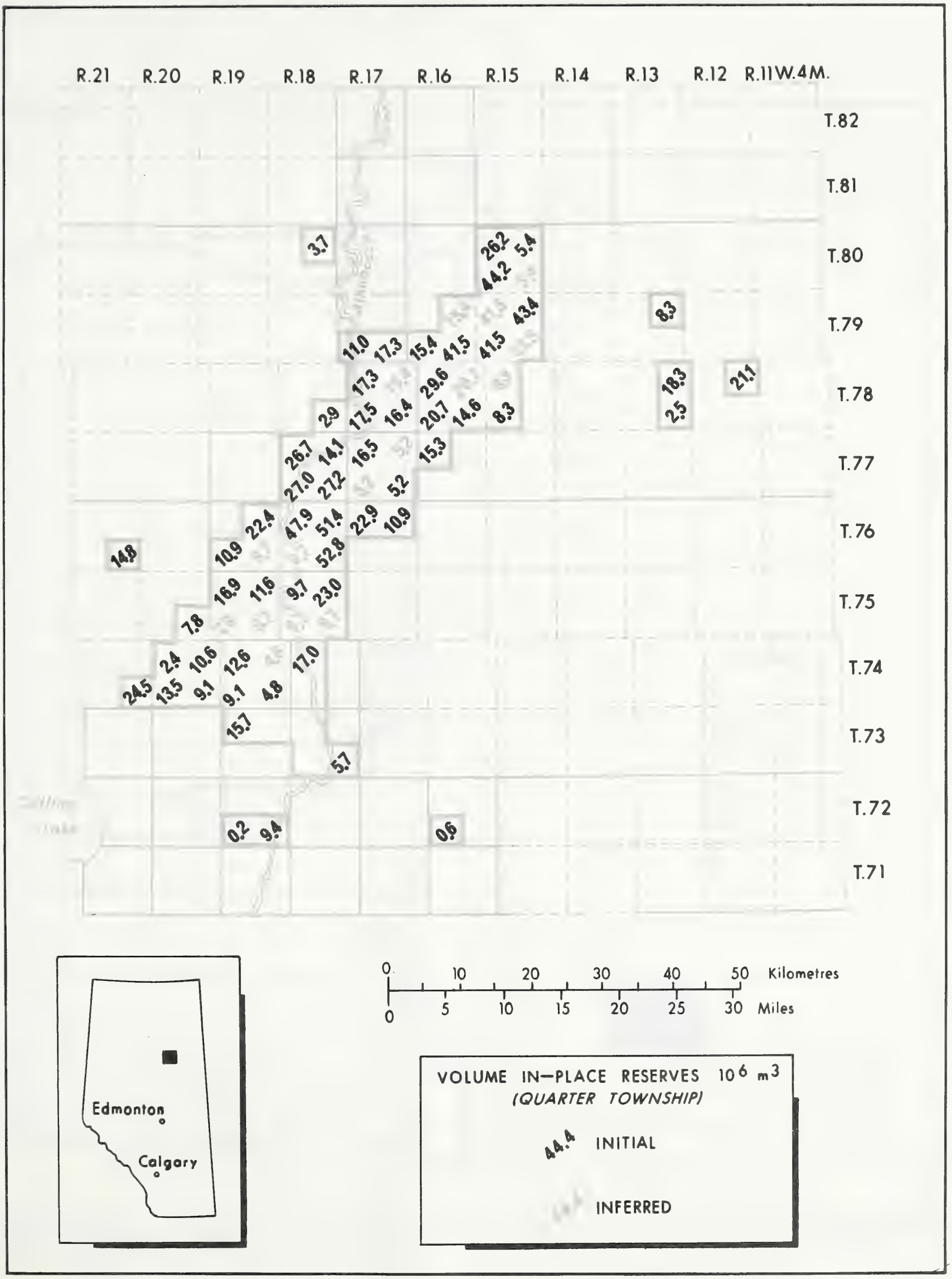
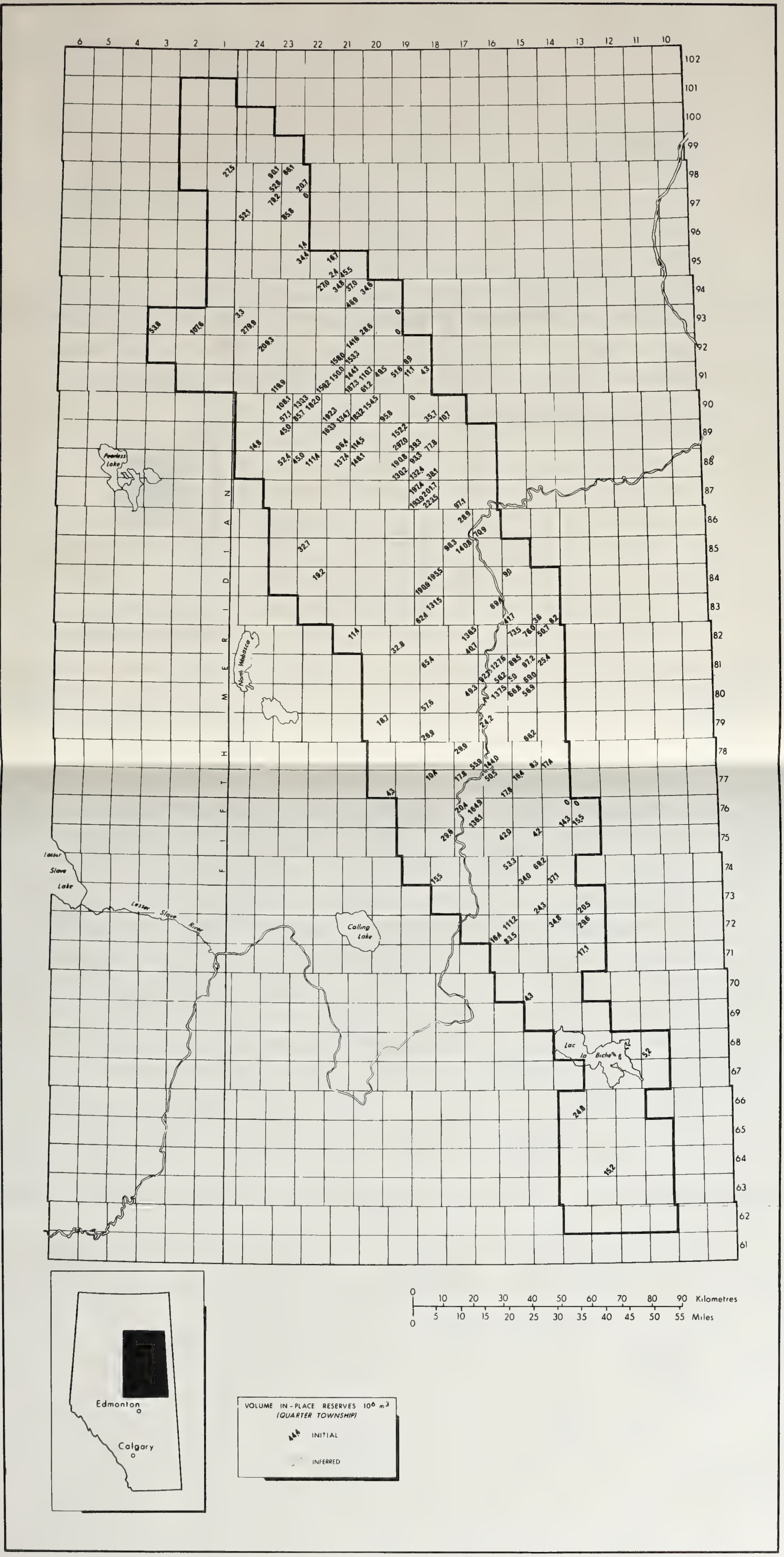
Edmonton
Calgary
VOLUME IN—PLACE RESERVES 10⁶ m³
(QUARTER TOWNSHIP)
44.4 INITIAL
INFERRED
0 10 20 30 40 50 Kilometres
0 5 10 15 20 25 30 Miles



ATHABASCA — LOWER GRAND RAPIDS 1984



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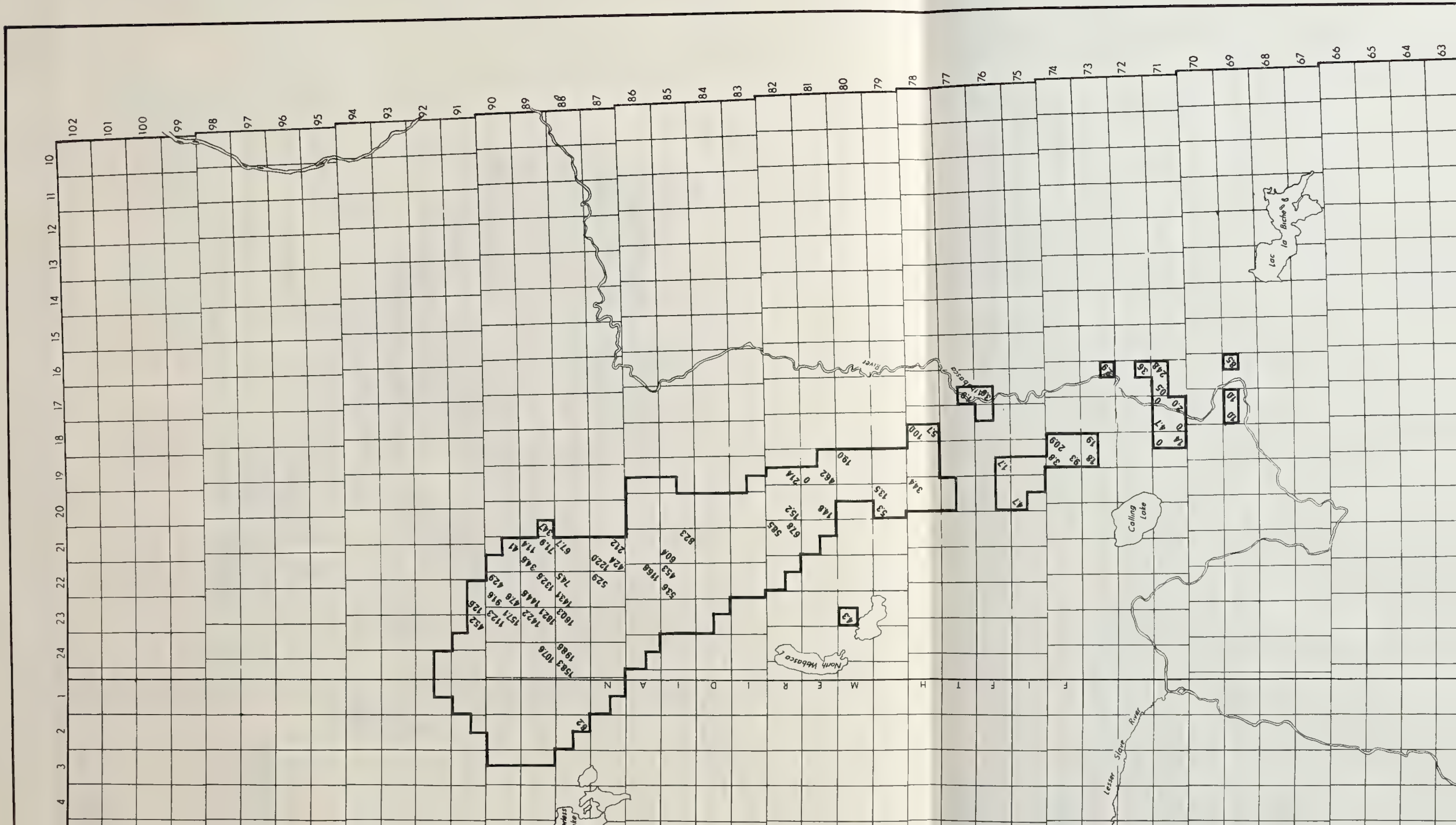
Lac la Biche
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Lesser Slave River
River
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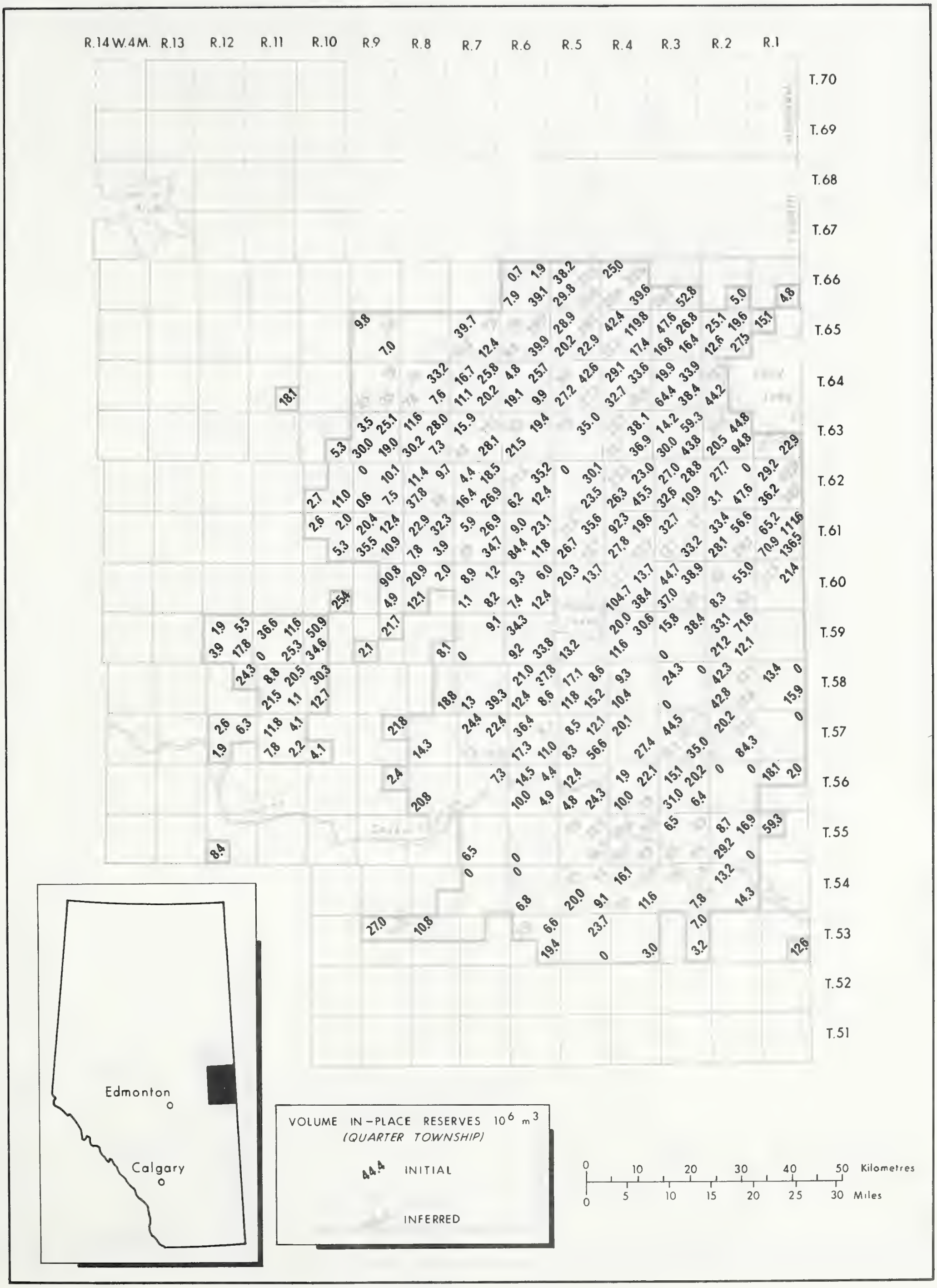
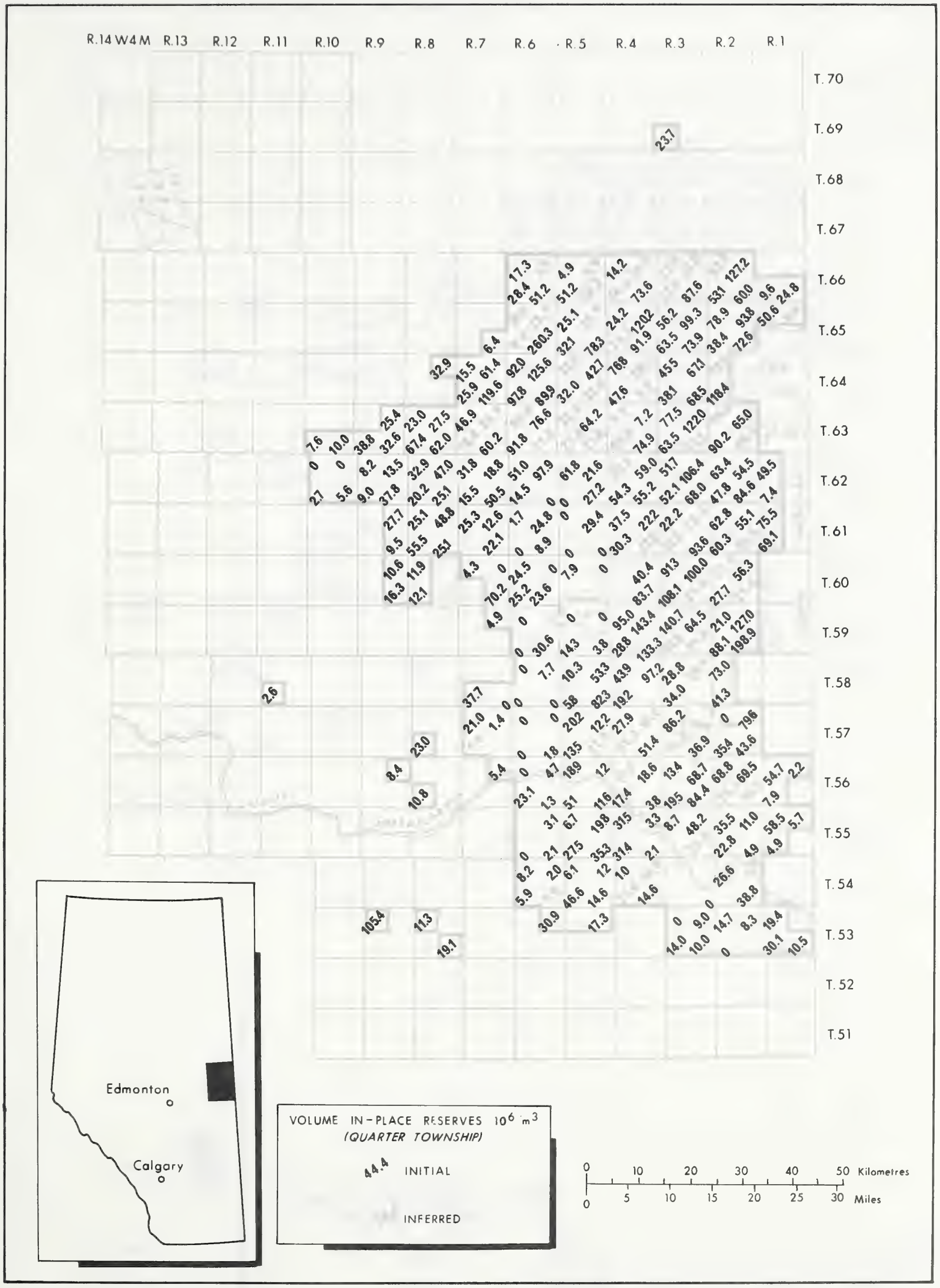
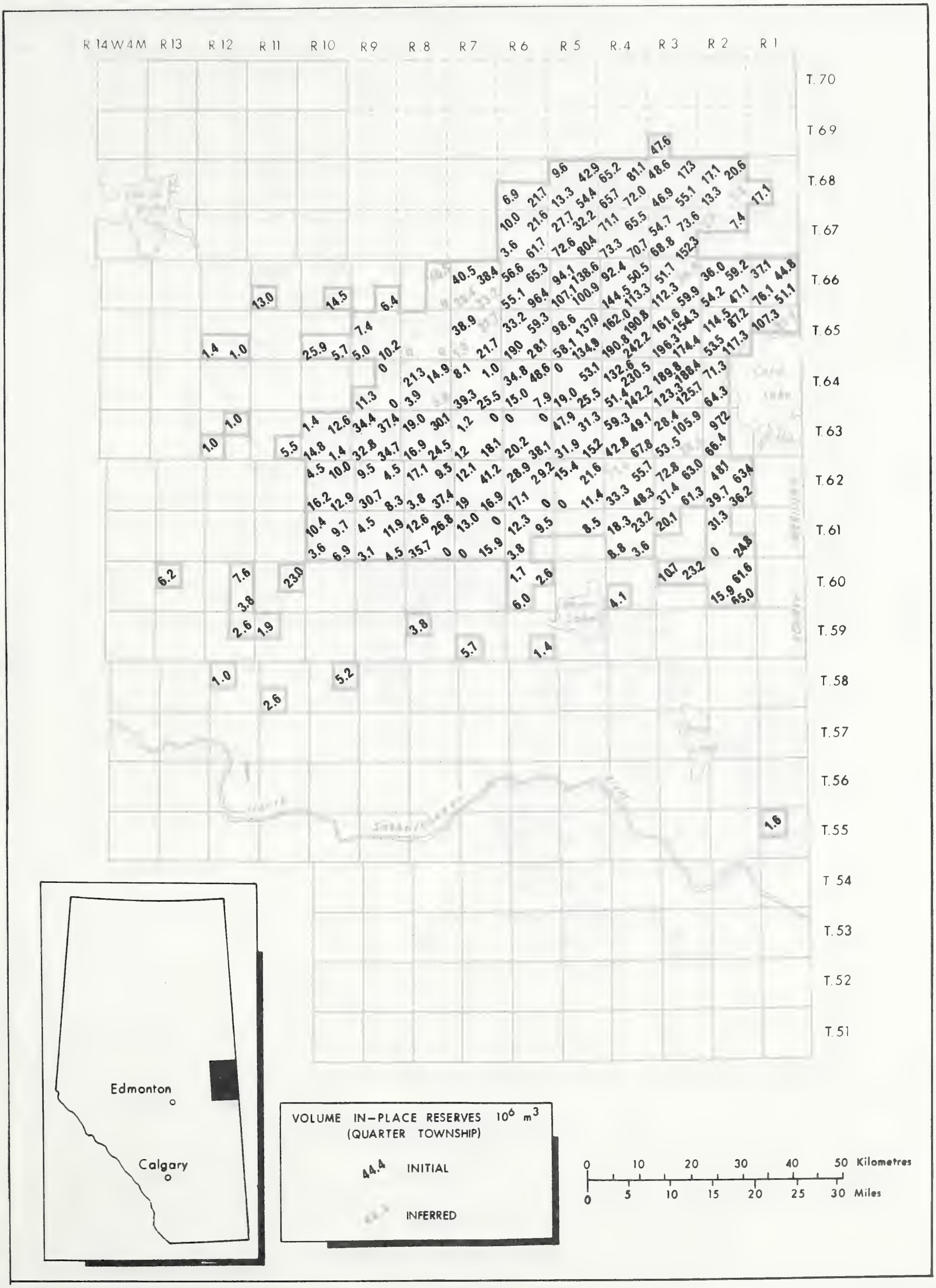


COLD LAKE - UPPER GRAND RAPIDS 1984



COLD LAKE – LOWER GRAND RAPIDS 1984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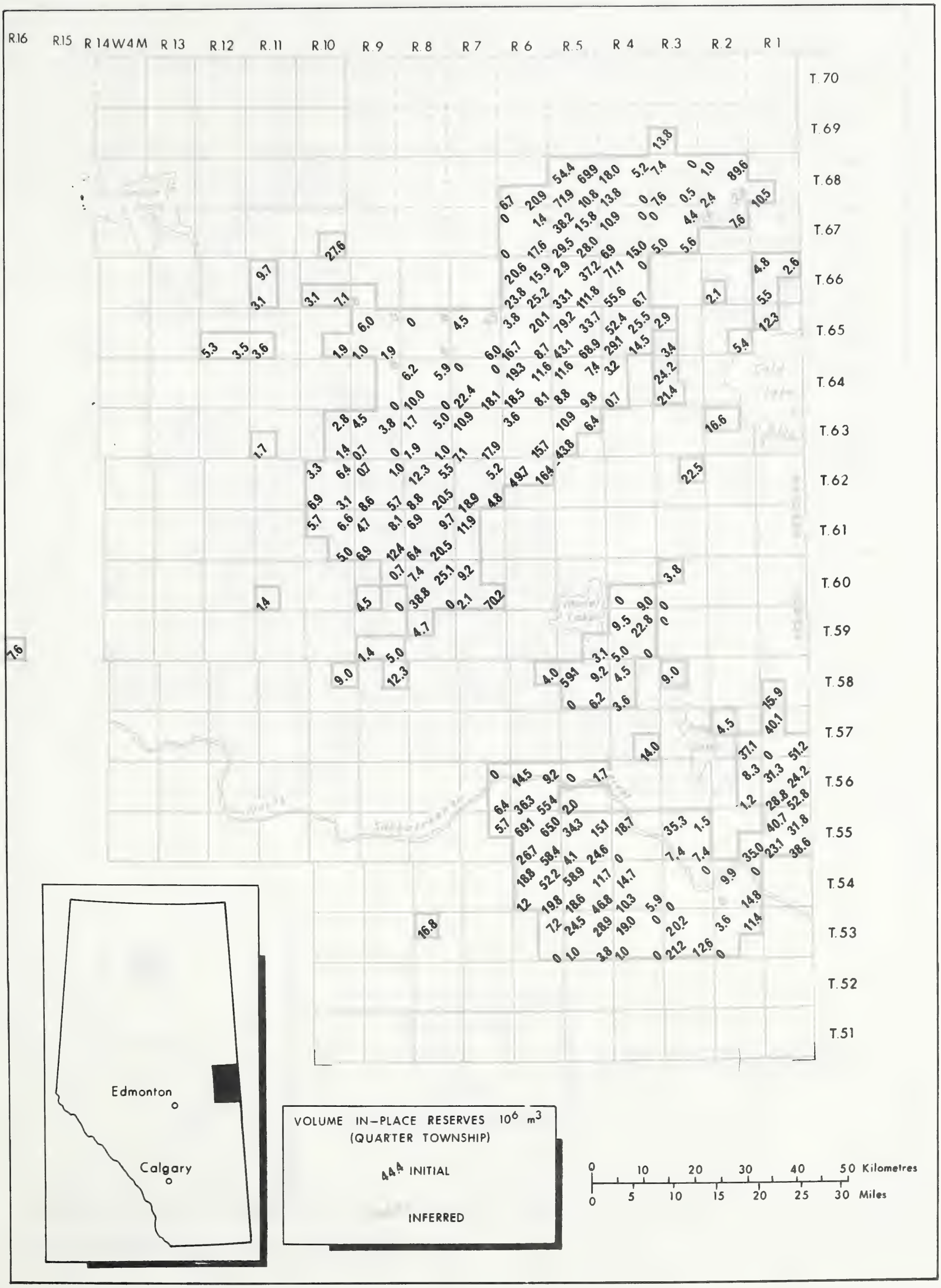
Edmonton
Calgary
VOLUME IN–PLACE RESERVES 10⁶ m³
(QUARTER TOWNSHIP)
44.4 INITIAL
INFERRED
0 10 20 30 40 50 Kilometres
0 5 10 15 20 25 30 Miles

Map 12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Calgary
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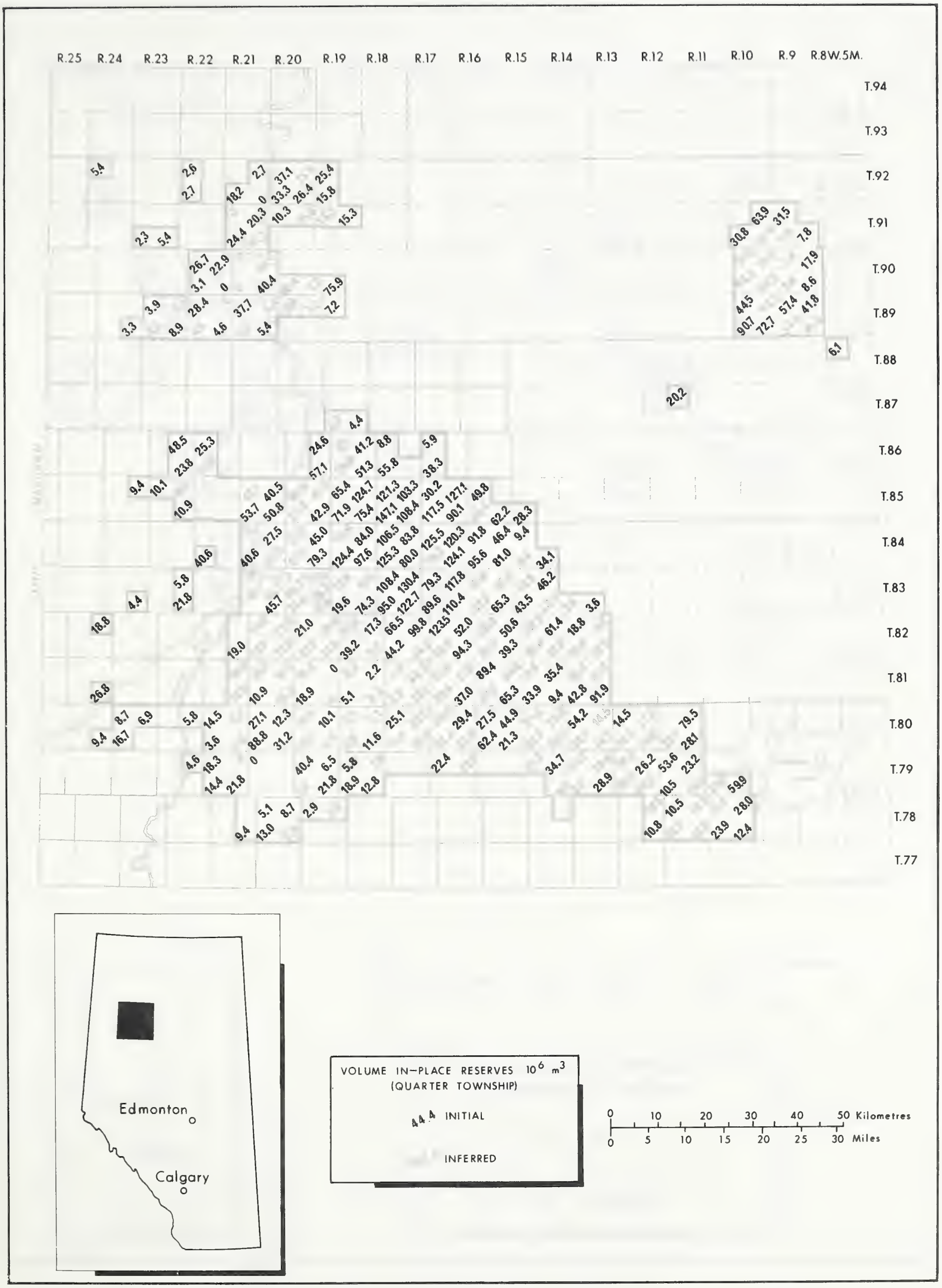
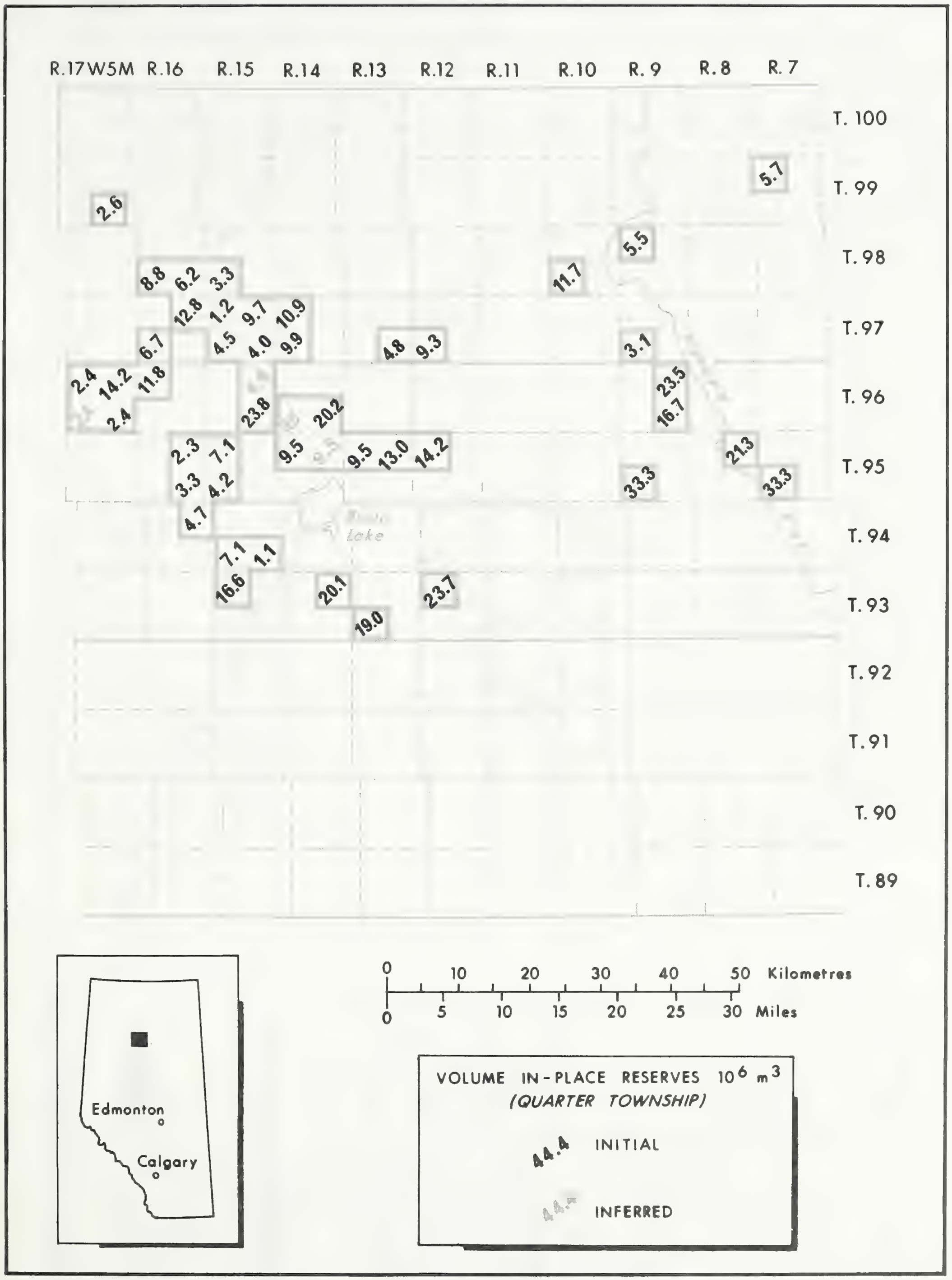
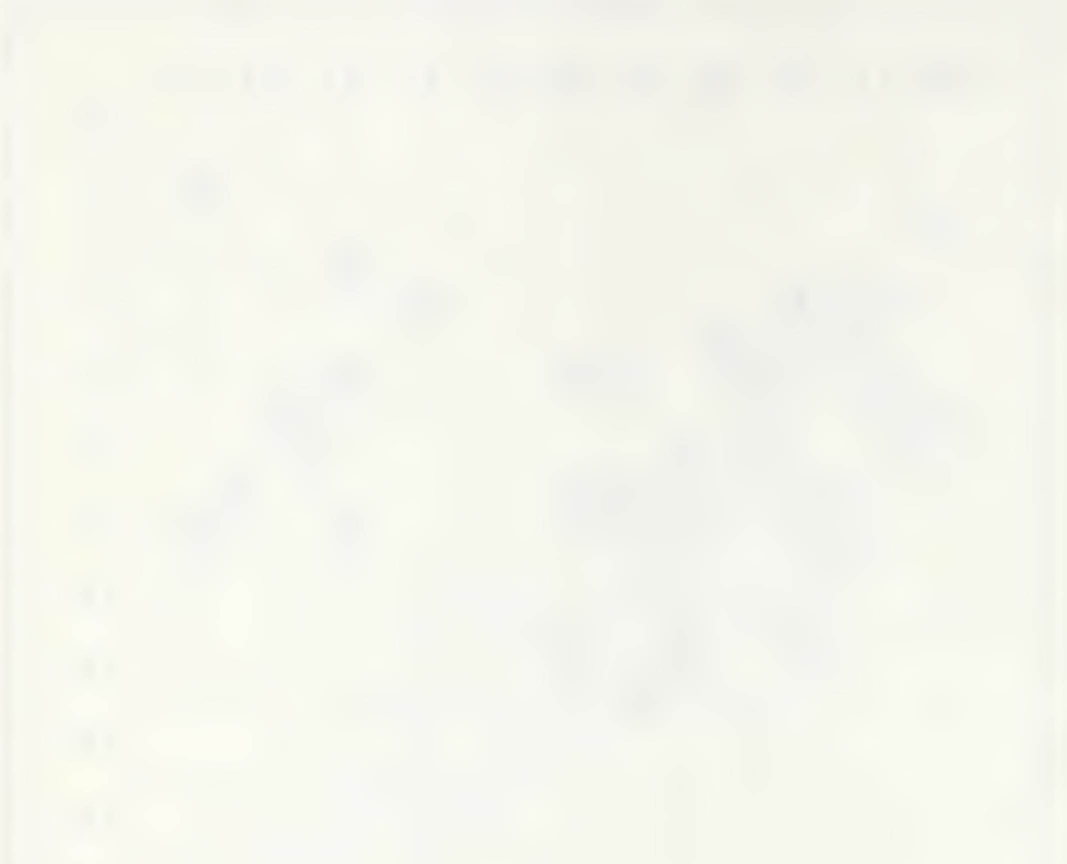
(QUARTER TOWNSHIP)
44.4 INITIAL
INFERRED
0 10 20 30 40 50 Kilometres
0 5 10 15 20 25 30 Miles


R.25 R.24 R.23 R.22 R.21 R.20 R.19 R.18 R.17 R.16 R.15 R.14 R.13 R.12 R.11 R.10 R.9 R.8W.5M.
T.94
T.93
T.92
T.91
T.90
T.89
T.88
T.87
T.86
T.85
T.84
T.83
T.82
T.81
T.80
T.79
T.78
T.77
Edmonton
Calgary
VOLUME IN–PLACE RESERVES 10^6 m^3
(QUARTER TOWNSHIP)
44.4 INITIAL
INFERRED
0 10 20 30 40 50 Kilometres
0 5 10 15 20 25 30 Miles

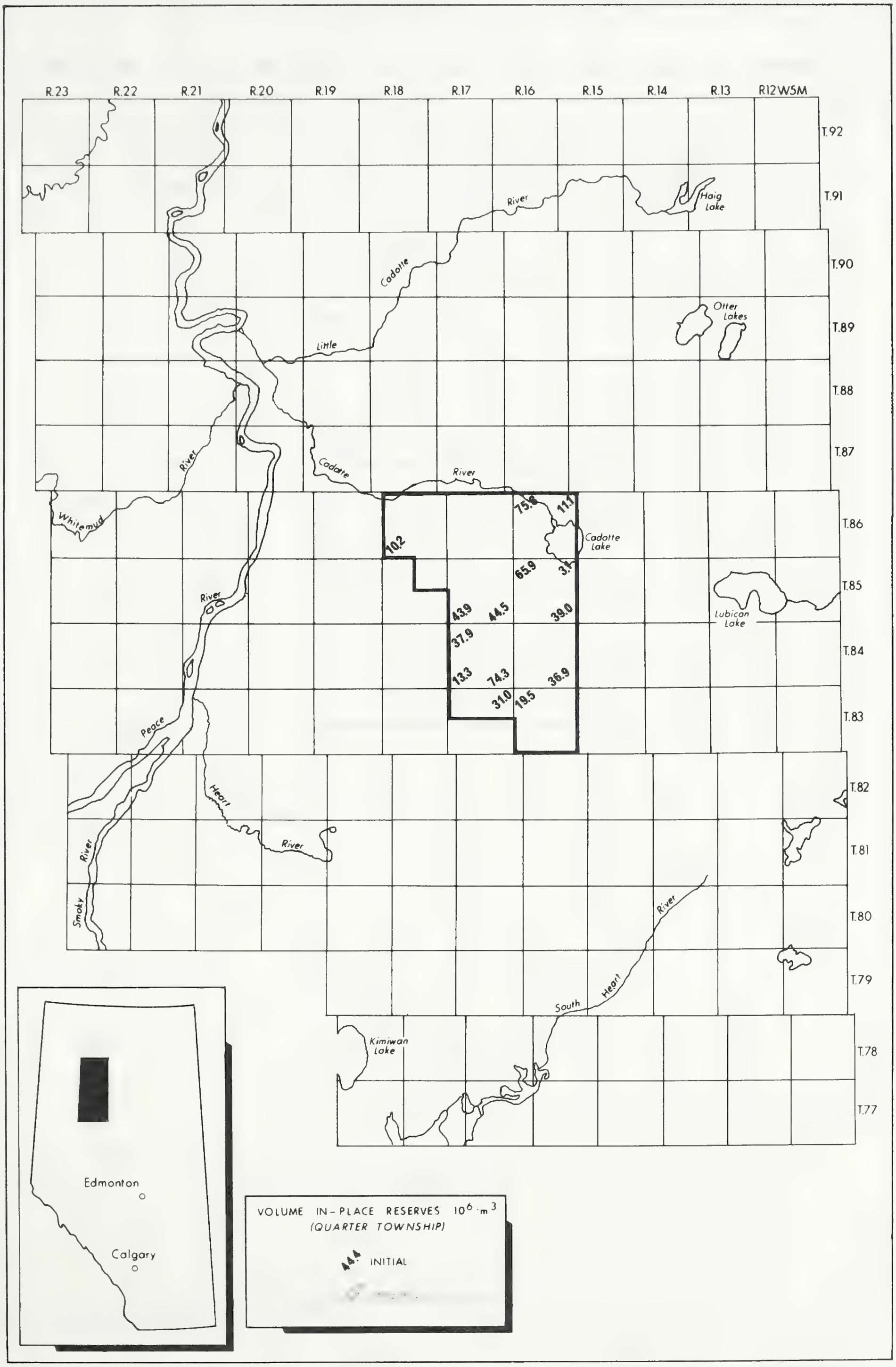
PEACE RIVER - BLUESKY - BULLHEAD 1984



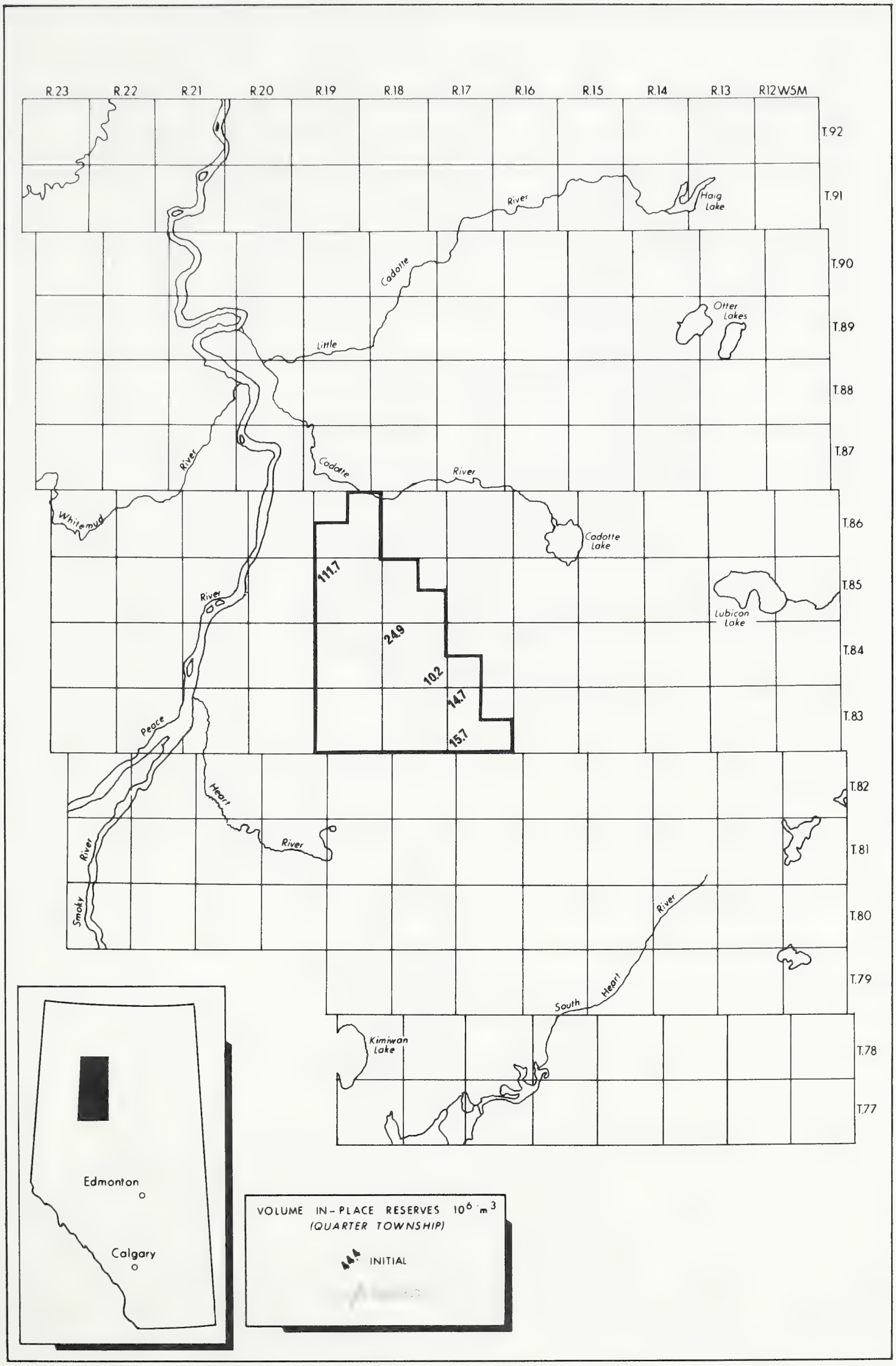
PEACE RIVER— BLUESKY— GETHING 1984



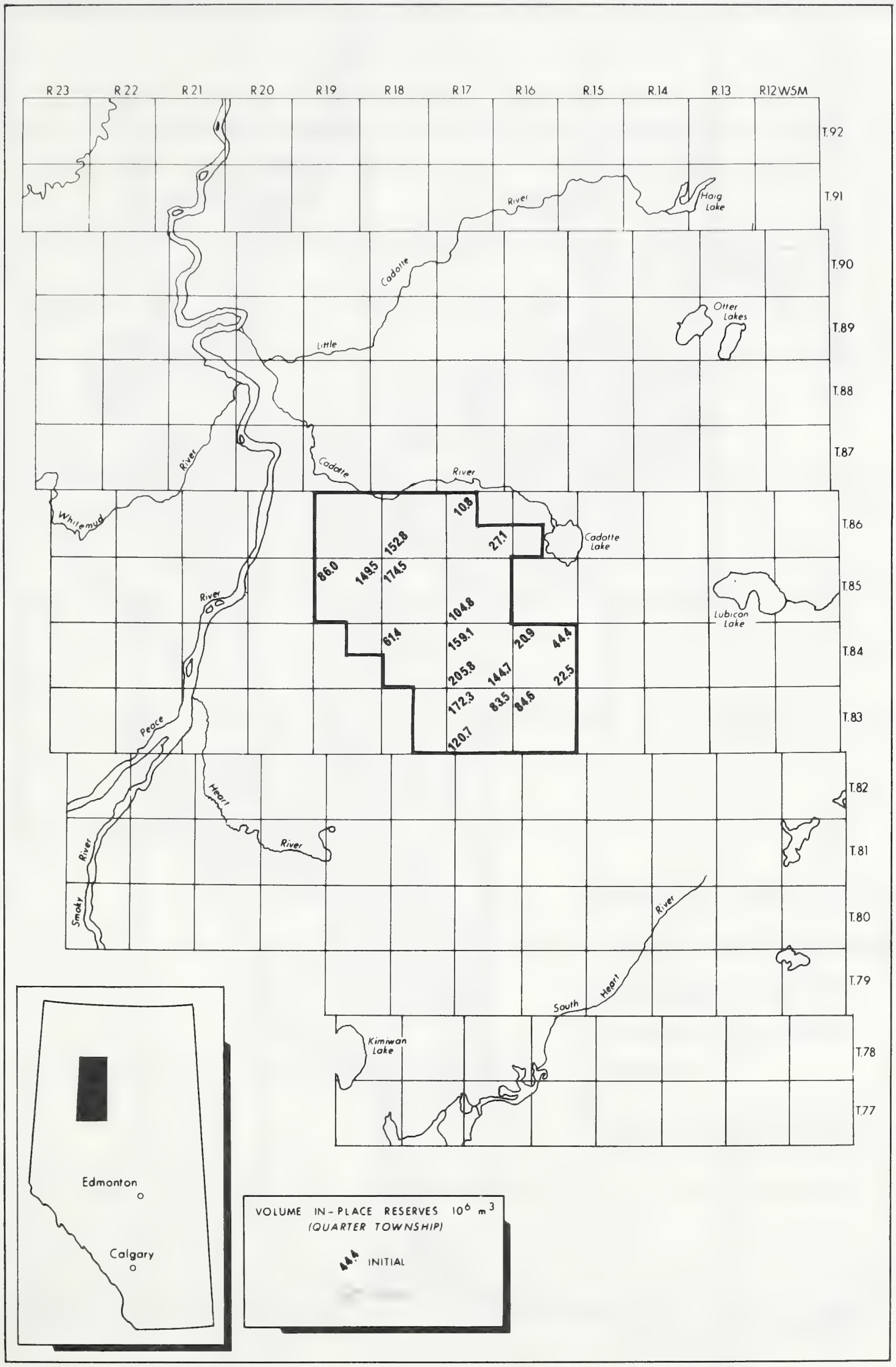
Map 15

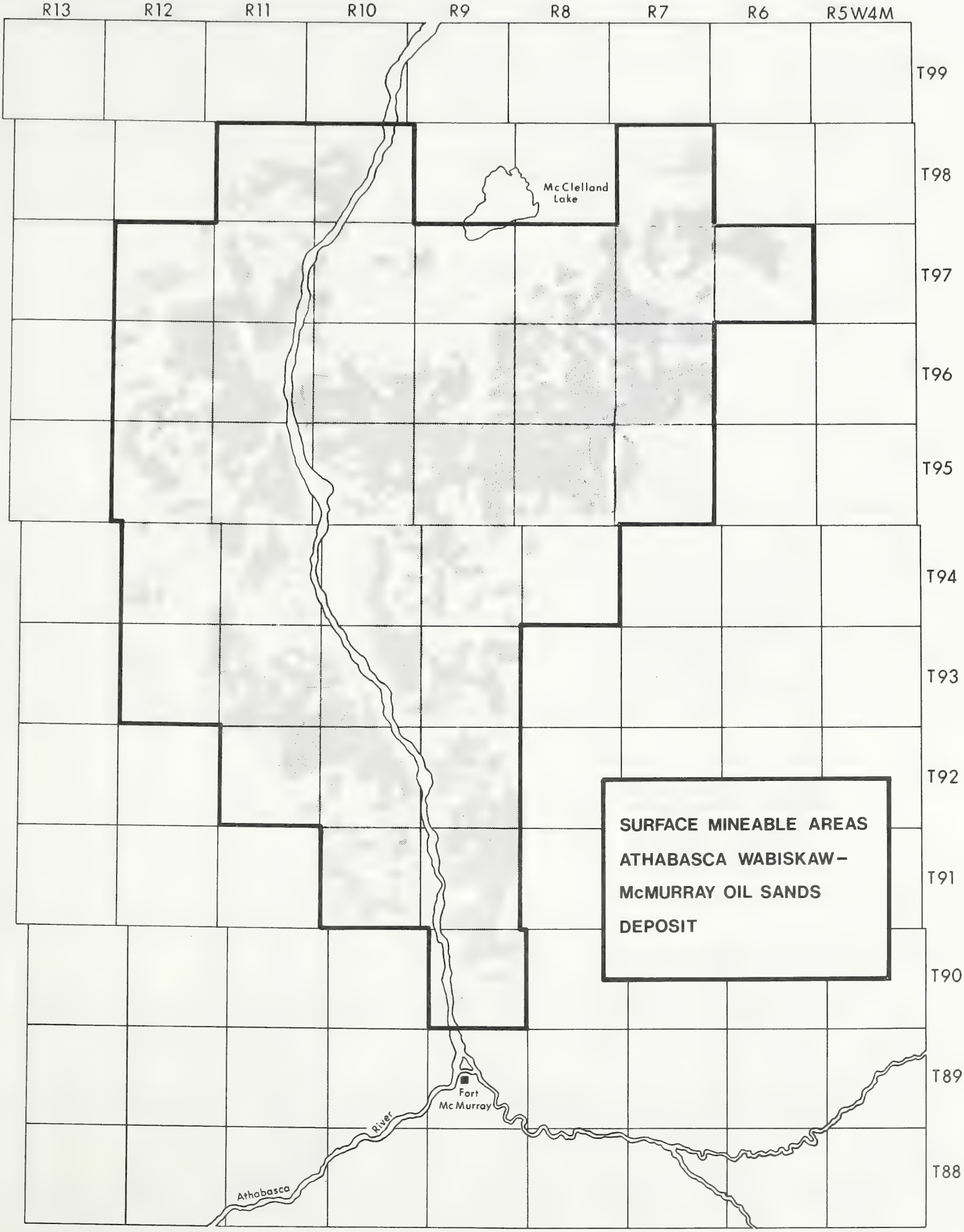

R.23
R.22
R.21
R.20
R.19
R.18
R.17
R.16
R.15
R.14
R.13
R12W5M
T.92
T.91
T.90
T.89
T.88
T.87
T.86
T.85
T.84
T.83
T.82
T.81
T.80
T.79
T.78
T.77
Cadotte River
Little Cadotte River
Haig Lake
Otter Lakes
Whitemud River
Cadotte Lake
Lubicon Lake
Peace River
Heart River
Smoky River
South Heart River
Kimiwan Lake
75.8
11.1
10.2
65.9
3.1
43.9
44.5
39.0
37.9
13.3
74.3
36.9
31.0
19.5
Edmonton
Calgary
VOLUME IN-PLACE RESERVES 10⁶·m³
(QUARTER TOWNSHIP)
44.4 INITIAL

Map 16

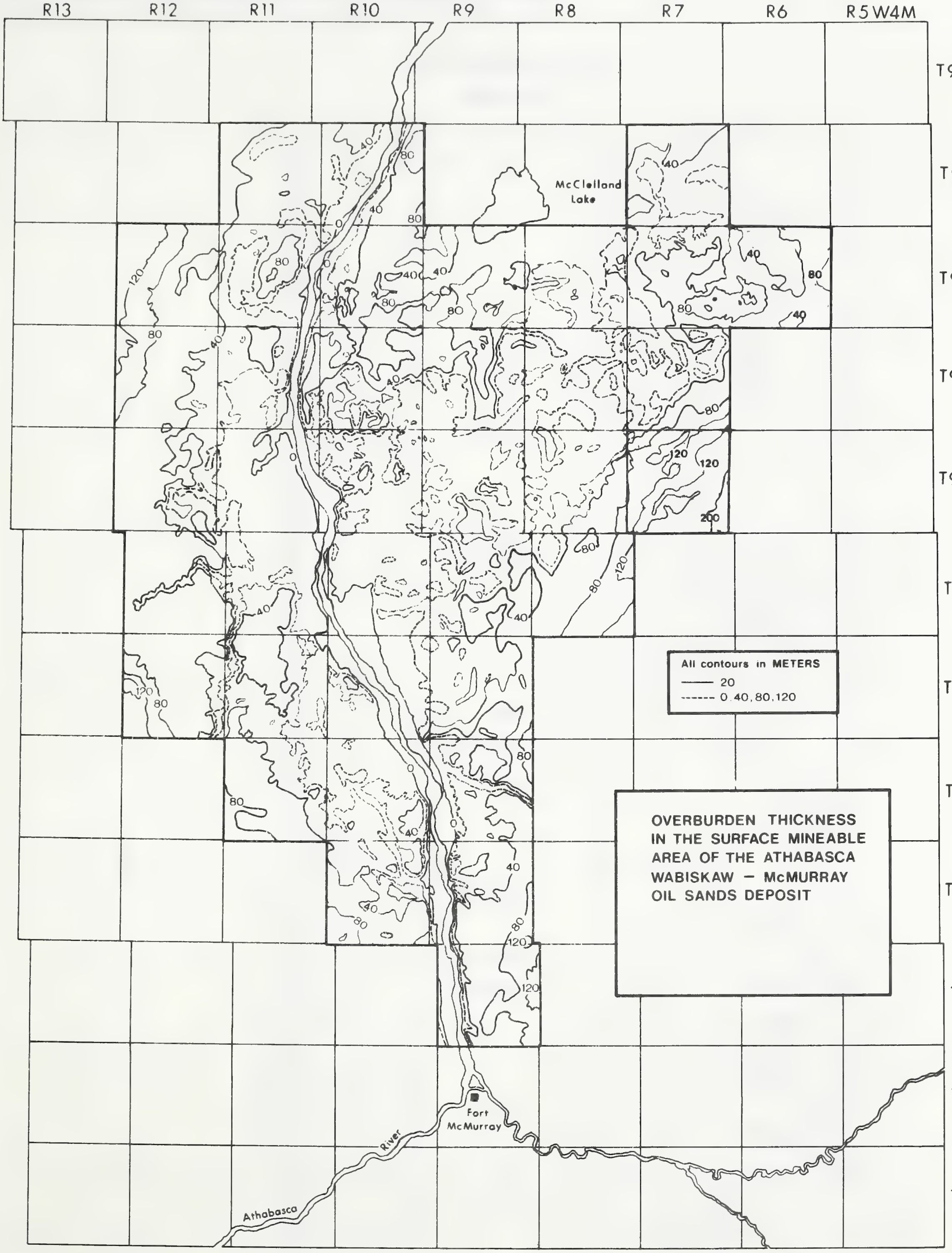

R.23
R.22
R.21
R.20
R.19
R.18
R.17
R.16
R.15
R.14
R.13
R12W5M
T.92
T.91
T.90
T.89
T.88
T.87
T.86
T.85
T.84
T.83
T.82
T.81
T.80
T.79
T.78
T.77
River
Haig Lake
Cadotte
Otter Lakes
Little
River
Cadotte
River
Whitemud
Cadotte Lake
Lubicon Lake
River
Peace
111.7
24.9
10.2
14.7
15.7
Heart
River
River
Smoky
River
South
Heart
Kimiwan Lake
Edmonton
Calgary
VOLUME IN-PLACE RESERVES 10^6 m^3
(QUARTER TOWNSHIP)
44.4 INITIAL

Map 17


R 23
R 22
R 21
R 20
R 19
R 18
R 17
R 16
R 15
R 14
R 13
R12 W5M
T.92
T.91
T.90
T.89
T.88
T.87
T.86
T.85
T.84
T.83
T.82
T.81
T.80
T.79
T.78
T.77
River
Haig Lake
Cadotte
Otter Lakes
Little
River
Cadotte
River
Whitemud
Cadotte Lake
Lubicon Lake
River
Peace
Heart
River
River
Smoky
River
South
Heart
Kimiwan Lake
10.8
27.1
152.8
86.0
149.5
174.5
104.8
61.4
159.1
20.9
44.4
205.8
144.7
22.5
172.3
83.5
84.6
120.7
Edmonton
Calgary
VOLUME IN-PLACE RESERVES 10⁶ m³
(QUARTER TOWNSHIP)
44.4 INITIAL



SURFACE MINEABLE AREAS ATHABASCA WABISKAW–McMURRAY OIL SANDS DEPOSIT



OVERBURDEN THICKNESS IN THE SURFACE MINEABLE AREA OF THE ATHABASCA WABISKAW – McMURRAY OIL SANDS DEPOSIT

Figure 1 Grosmont well 7-35-89-24 W4M

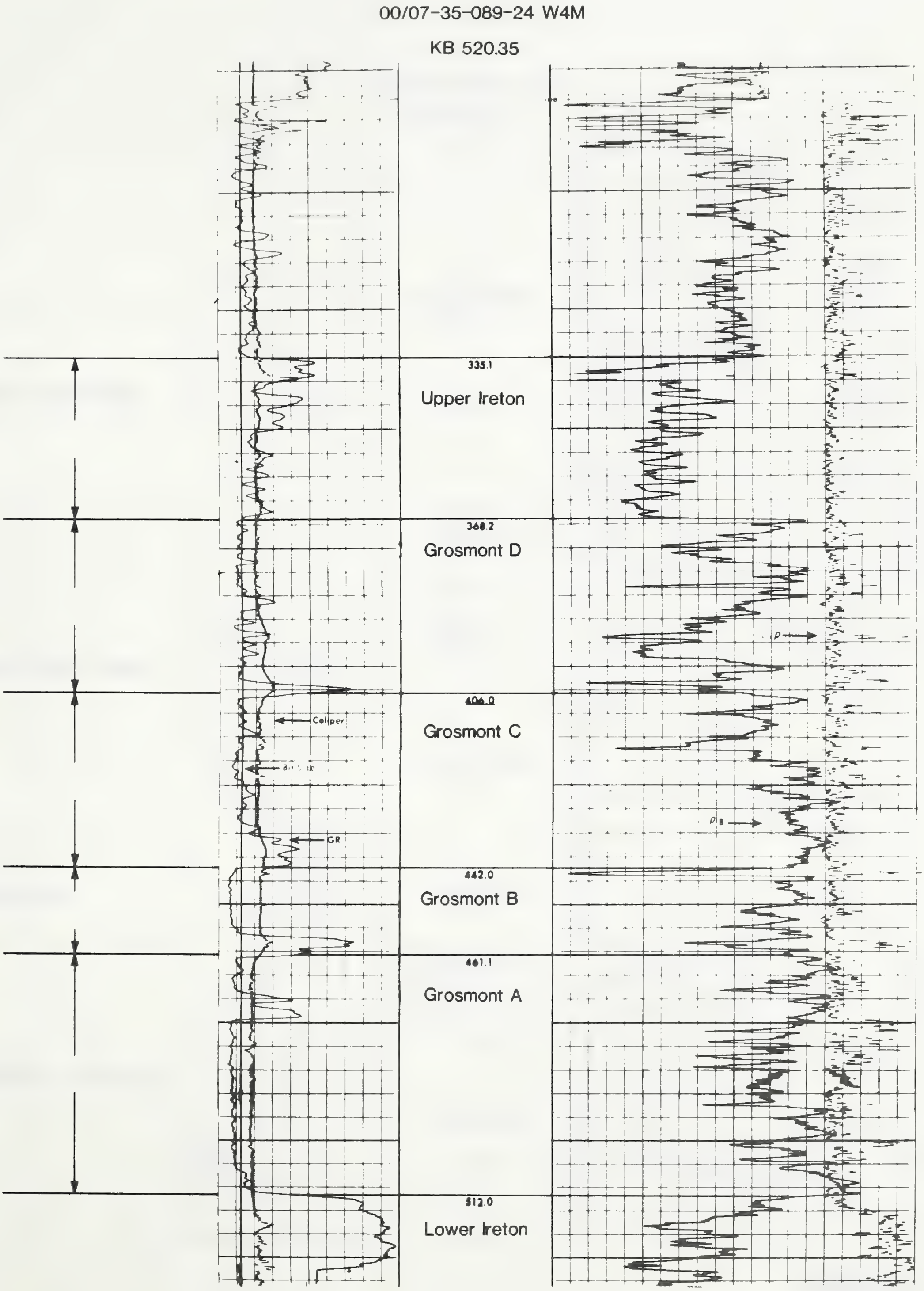
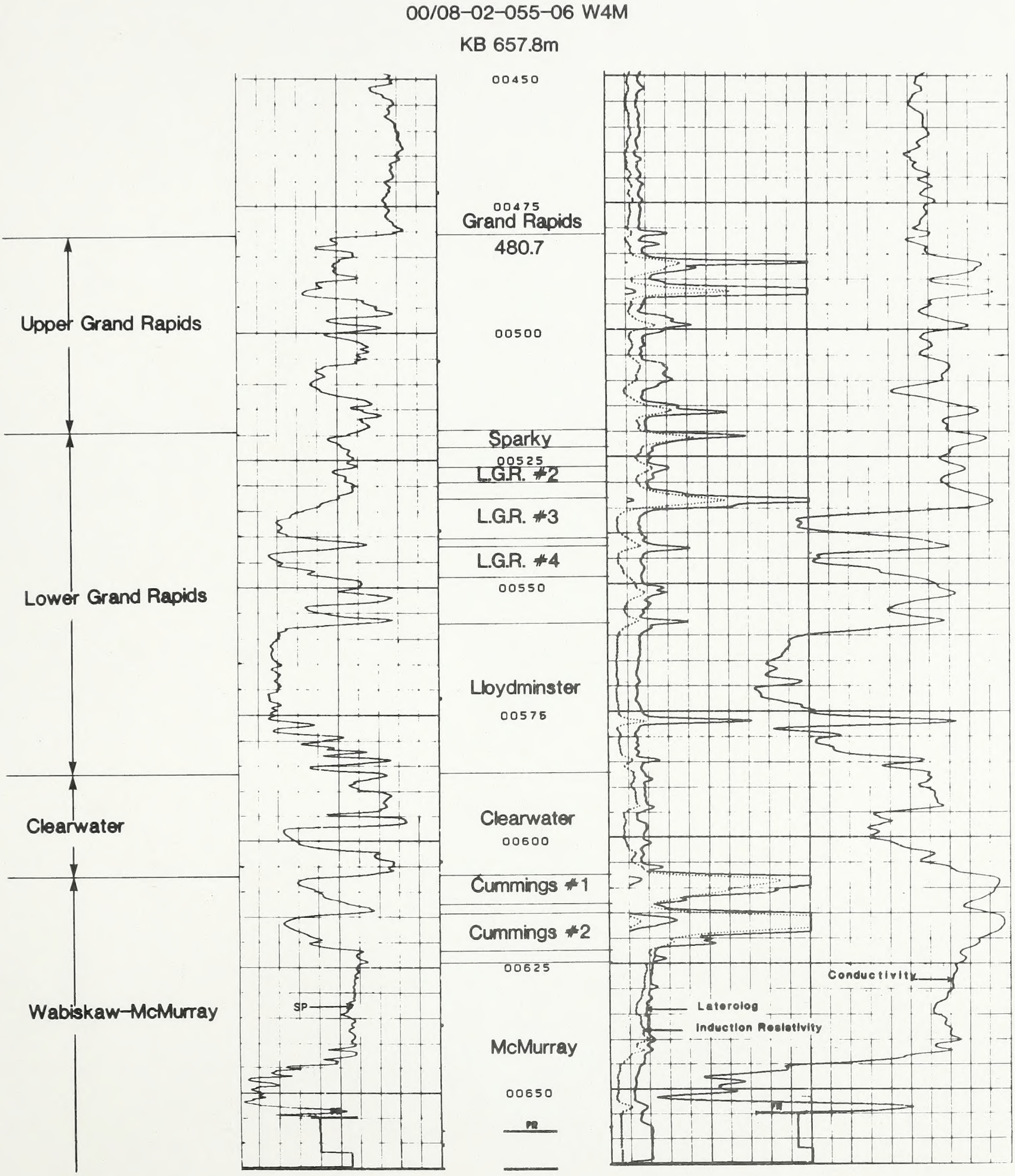


Figure 2 Lindbergh well 8-2-55-6W4M



N.L.C. - B.N.C.
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